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Give a Regulator the Attention it Deserves

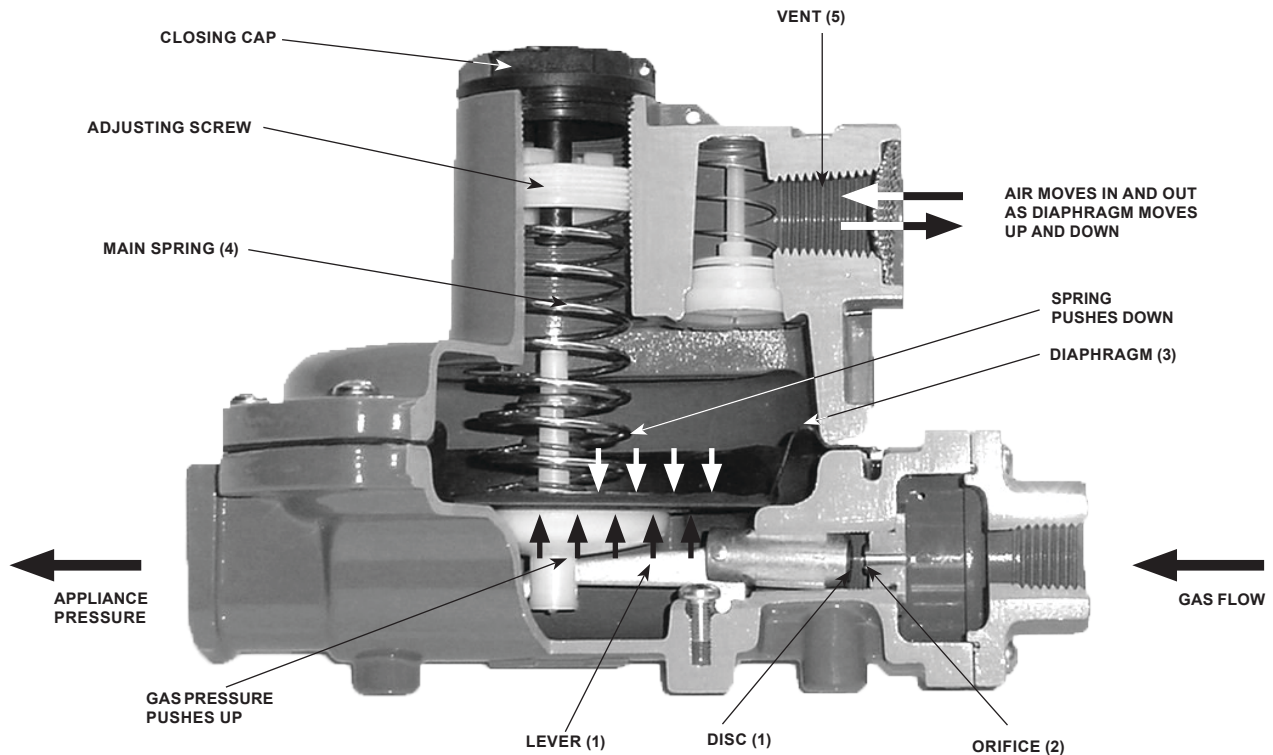


Figure 1. LP-Gas Regulator Parts

Introduction

LP-Gas regulators, after installation, get little attention or consideration as long as the regulator continues to do a good job. However, if troubles occur, the regulator operation impacts both the customer and the gas dealer and requires the full attention of the gas serviceman.

Proper installation and maintenance of the regulator during its time in service will pay big dividends in the form of increased customer satisfaction and fewer service calls.

Before examining some of the things you should be doing with regulator installation, let's look at the

regulator. Understanding the regulator components and operation makes it easier to see how and where problems develop.

Parts and Principle of Operation of the Regulator

The basic regulator parts (Figure 1) are:

1. the valve disc and lever,
2. the orifice,
3. the diaphragm,
4. the main spring and
5. the vent

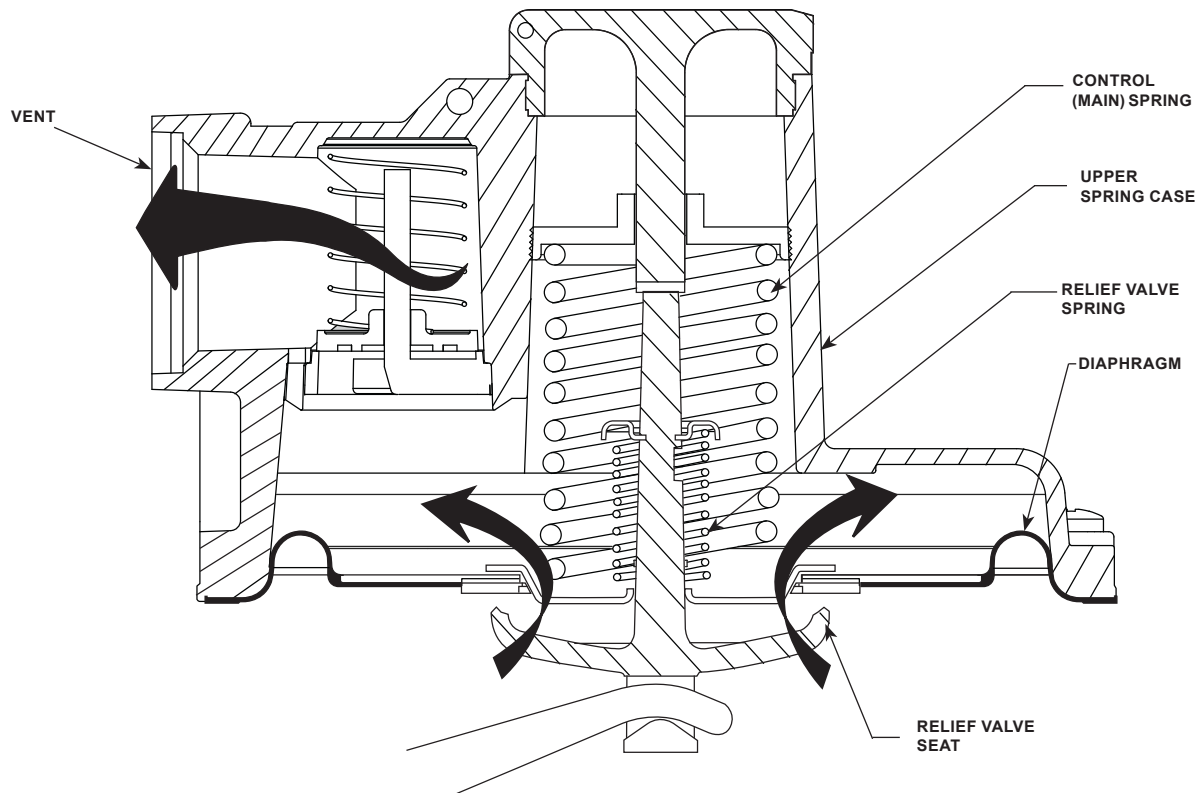


Figure 2. Internal Relief Valve being Opened by Excessive Gas Pressure

As gas pressure enters the regulator inlet, it goes through the orifice, past the disc and pushes upward under the diaphragm and against the main spring. Since the valve lever is connected to the diaphragm, upward movement of the diaphragm causes the valve disc to move closer to the orifice. As downstream gas demand increases, pressure under the diaphragm decreases allowing the main spring to push the diaphragm downward opening the orifice. This way, the regulator maintains the desired appliance pressure, usually 11 in. w.c. / 27 mbar.

The regulator vent performs two important functions. First, when the regulator valve disc has to move against the orifice to restrict the gas flow, the diaphragm moves upward and air is expelled through the vent. As gas load increases, the diaphragm moves downward and the disc moves away from the orifice. Air is pulled in through the vent. A regulator must “breathe” through the vent to properly regulate downstream pressure.

Second, the regulator vent will exhaust LP-Gas when the internal relief valve opens. Every second stage

domestic and light commercial LP-Gas regulator reducing pressure down to appliance pressure must have an internal relief valve⁽¹⁾. Both the large main spring and the small relief valve spring inside the regulator act to hold the diaphragm down on the relief valve seat (Figure 1). When pressure under the diaphragm becomes too high, it overcomes both springs and allows the diaphragm to move away from the relief valve seat (Figure 2). Pressure then escapes through the regulator vent. An open internal relief valve can exhaust small bubbles of gas or large volumes of gas depending upon the condition that caused the overpressure situation.

Since the regulator must breathe to work properly, the vent cannot be blocked by snow, ice, mud, insects, etc. The vent must always be open. Make sure the screen is in place which keeps out insects such as wasps or mud daubers, which can build nests in the vent and plug the vent opening.

UL® 144, Standard for LP-Gas Regulators requires that the second stage regulator internal relief valve must open (begin-to-bubble) between 170% and 300%

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1. Large commercial or industrial regulators supplying 0.5 psig / 0.03 bar systems may not have an internal relief, but are required by NFPA 58 to have an external relief valve or another overpressure protection device that will limit downstream pressure to 2 psi / 0.14 bar or less under specific test requirements.

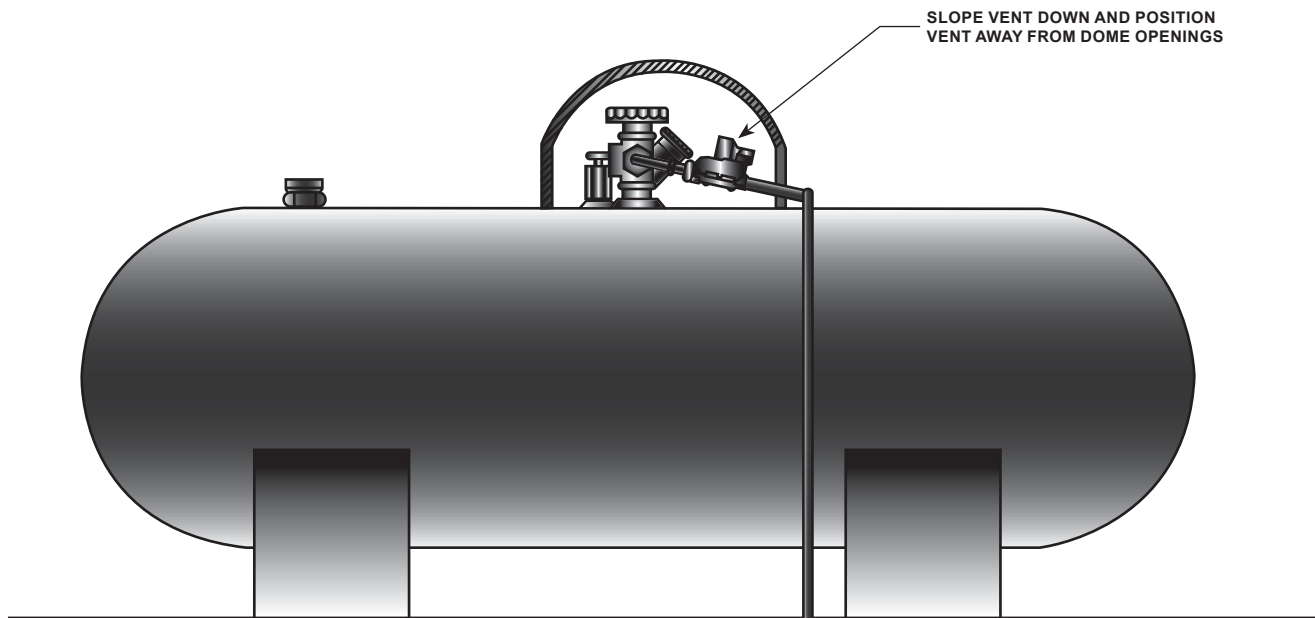


Figure 3. Tank Installation

of the regulator outlet setting. In other words, a regulator with an 11 in. w.c. / 27 mbar outlet setting must have its relief valve start-to-discharge when the pressure climbs into the 19 to 33 in. w.c. / 47 to 82 mbar range. The relief valve spring permits the relief valve to open before pressure gets above 33 in. w.c. / 82 mbar. UL® 144 and NFPA 58, Liquefied Petroleum Gas Code also requires the internal relief valve to limit downstream pressure to 2 psi / 0.14 bar if the second stage regulator valve disc is removed. Tampering with the relief valve mechanism is not recommended.

Installation is Important

A lot of initial (call backs shortly after installation) and long term (maybe years after installation) problems can be minimized by paying attention to the initial installation and by properly installing the regulator per manufacturer's instructions and NFPA 58 requirements.

General Installation Instructions

All regulator installations should be made in accordance with NFPA 58 and any state or local regulations and the manufacturer's instructions. Compliance with these requirements will minimize future regulator trouble calls and could easily prevent a future accident.

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Before Installing the Regulator

- Check for regulator damage, which might have occurred in shipment.
- Check for and remove any dirt or foreign material, which may have accumulated in the regulator body after removing the regulator from its shipping box.
- Blow out any debris, dirt or copper sulphate in the copper tubing and the pipeline. This is especially important for first-stage regulators or integral two-stage regulators on tanks and cylinder applications.
- Apply pipe compound to the male threads of the pipe and install the regulator.
- Make sure gas flow through the regulator is in the same direction as the flow arrow on the body. "Inlet" and "Outlet" connections are clearly marked. Surprisingly, regulators do occasionally get installed backwards and leak immediately out the vent when pressurized.

Installation Location

- Protect the regulator from vehicular traffic and damage from other external sources.
- Install the regulator with the vent pointed vertically down, see Figure 5. If the vent cannot be installed in a vertically down position, the regulator must be

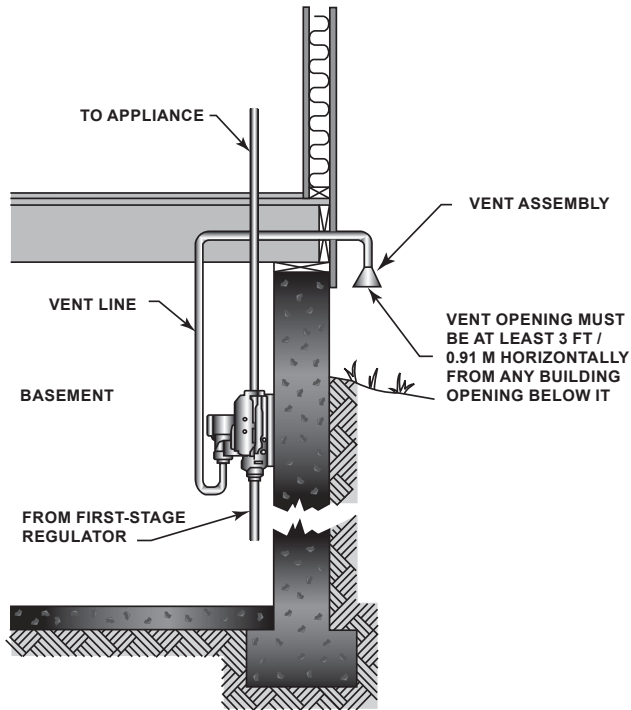


Figure 4. Typical Indoor Installation with Vent Line and Vent Assembly

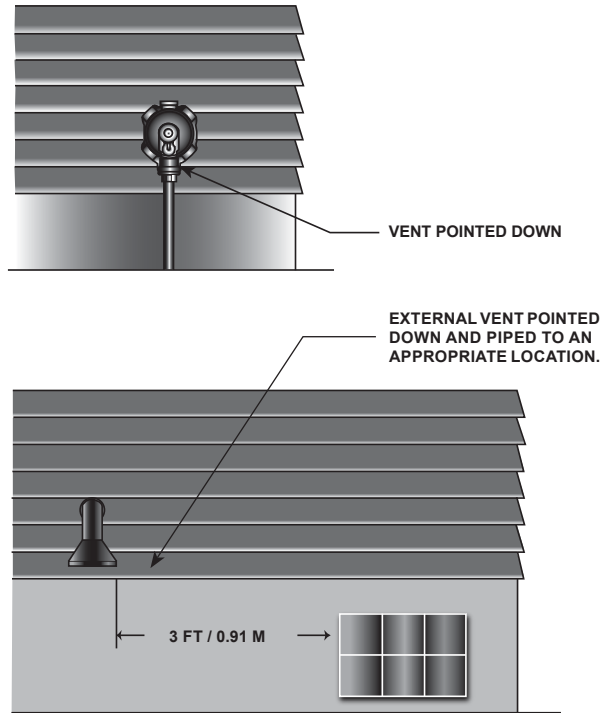


Figure 5. Typical Outdoor Installations with Regulator Vent and External Vent Pointing Downward

installed under a separate protective cover such as the tank dome, Figure 3. Installing the regulator with the vent down allows condensation to drain, minimizes the entry of water or other debris into the vent and minimizes vent blockage from freezing precipitation.

- Do not install the regulator in a location where there can be excessive water accumulation or ice formation, such as directly beneath a down spout, gutter or roof line of building. Even a protective hood may not provide adequate protection in these instances.
- Install the regulator so that any gas discharge through the vent or vent assembly is over 3 ft / 0.91 m horizontally from any building opening below the level of discharge. See Figure 5.
- Install the regulator so that any gas discharge through the vent or vent assembly is over 5 ft / 1.52 m in any direction from an ignition source.
- Install the regulator high enough above ground level - at least 18 in. / 457 mm – so that rain splatter cannot freeze in the vent.

Regulators Subjected to Heavy Snow Conditions

Regulators should always be installed above any possible snow or ice level. Installations in areas with heavy snowfall, drifting snow and snow/ice sliding off the roof may require additional regulator and vent protection so as not to block the vent or damage the regulator or piping attached to the regulator. Piping into and out of the regulator may need to be secured to the building so as to resist fracture from falling ice and snow. Additional installation options include, but are not limited to:

- Installing the regulator under a separate hood or enclosure,
- Installing the regulator in doors (such as a basement area) and venting to a protected location,
- Installing the regulator high under an eave and securing the piping.

The important part is to provide suitable protection to the regulator and piping so that the vent does not become blocked or the piping and regulator do not break from falling snow and ice.

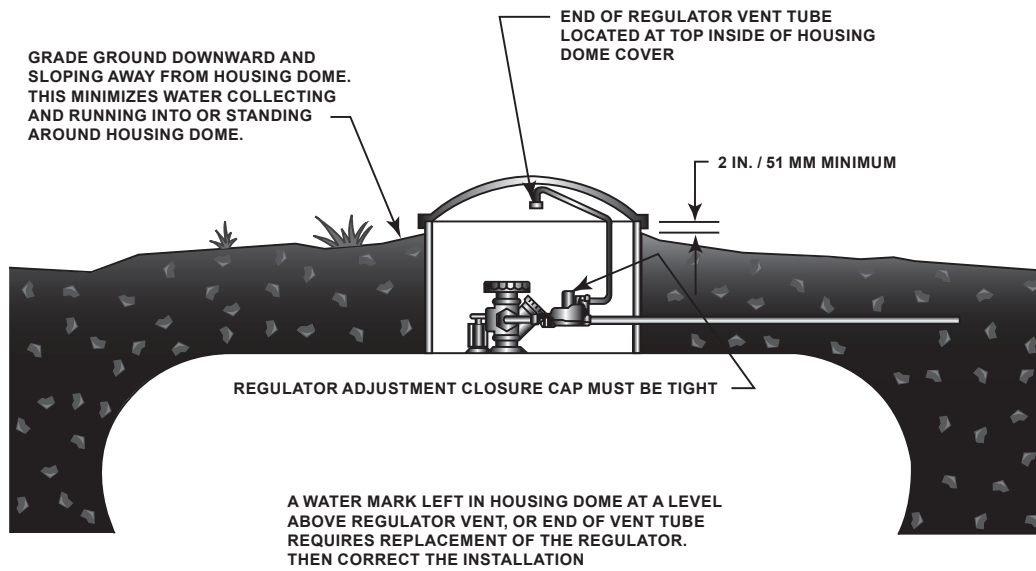


Figure 6. Underground Installation

Horizontally Installed Regulators

Horizontally mounted regulators such as first stage regulators or integral two-stage regulators installed in single cylinder installations and ASME tanks, must be installed beneath a protective cover or under the ASME tank dome, see Figure 3. If possible, slope or turn the vent down sufficiently to allow any condensation to drain out of the spring case. Be careful that the slot in the tank dome or protective cover for the regulator's outlet piping does not expose the vent to the elements.

Indoor Installations

By code, regulators installed indoors have limited inlet pressure, and they require a vent line to the outside of the building as shown in Figure 4. A vent assembly, such as Fisher™ Y602 Series, should be used at the end of the vent line. The same installation precautions apply to vent assemblies as the regulator vents covered previously.

Vent piping must not restrict the flow passage of the regulator's internal relief valve. Use the same size vent pipe or tubing as the vent size. If the vent is 3/4 NPT pipe size, then use no less than 3/4 NPT pipe or tubing ID for the vent line. To install the vent line, remove the vent screen and apply a good grade of pipe dope to the male threads of the line.

Sometimes the vent line will make the regulator unstable, and it will pulsate or chatter. Such problems are minimized by using a large vent line, keeping the vent line as short as possible and using as few elbows as possible. If instability still occurs, a stabilizer vent assembly (another Y602 Series external vent assembly) at the end of the line may help. Adding or removing vent line length a few inches may also solve the problem.

Underground Installations

Underground container systems require a vent tube to prevent water from entering the regulator spring case, see Figure 6. Remove the vent screen and install a vent tube. The vent tube must be run from the regulator vent to above the maximum water table. The vent tube opening must terminate at the extreme top inside of the dome cover. Make sure the regulator's closing cap is on tightly, and maintain drainage away from the dome at all times.

If an integral regulator is used on an underground tank, 2 vent lines will be required.

After Installation

Once the regulator is properly installed, the vast majority of operating problems can be attributed to chips—pieces of dirt, pipe scale and other foreign materials; blocked vents and on occasion, water in the gas.

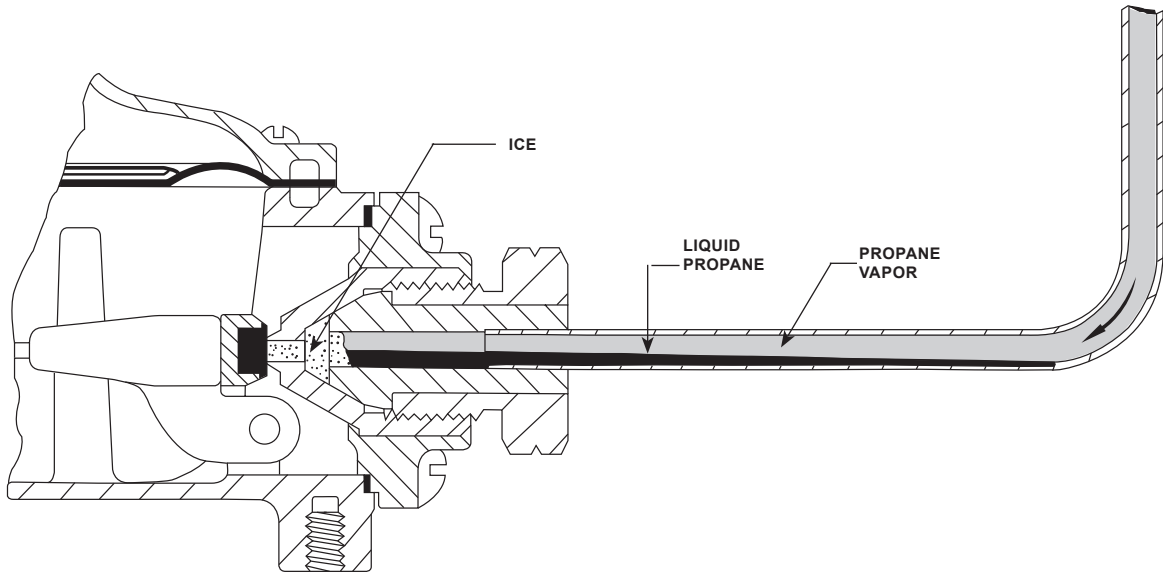


Figure 7. Water in LP-Gas Can Turn to Ice at the Regulator's Inlet and Block Gas Flow

What to Do About Chips (Debris)

The valve disc and the orifice are critical components for controlling pressure, and especially at lockup (no flow). The synthetic rubber valve disc must be smooth and flat; the orifice must be free of nicks and its “nose” properly formed. A little dirt or chip lodged between the disc and orifice can cause slight pressure deviations that may result in unacceptable regulator performance when the regulator goes to pilot load or lockup.

What makes the chip's work easier is the fact that the disc rarely moves more than a few thousandths of an inch away from the orifice, even on heavy loads. Trouble shows up when there isn't much demand for gas—perhaps just the pilot lights are in use. At that time the disc has to move right up against the orifice to throttle the very small flow. If chips hold the disc far enough away (Figure 8) to allow just a bit more flow than is being consumed, the pressure in the house piping will build up above the desired appliance pressure.

Excessive appliance pressure means customer service calls for poor appliance operation or the internal relief valve in the regulator opens to discharge some of the excess pressure resulting in gas loss and gas odor complaints.

To minimize chips, always blow out all pipe or tubing fittings when making the installation. When changing ICC cylinders, blow or clean out the cylinder connection before attaching the pigtail to the cylinder service valve.

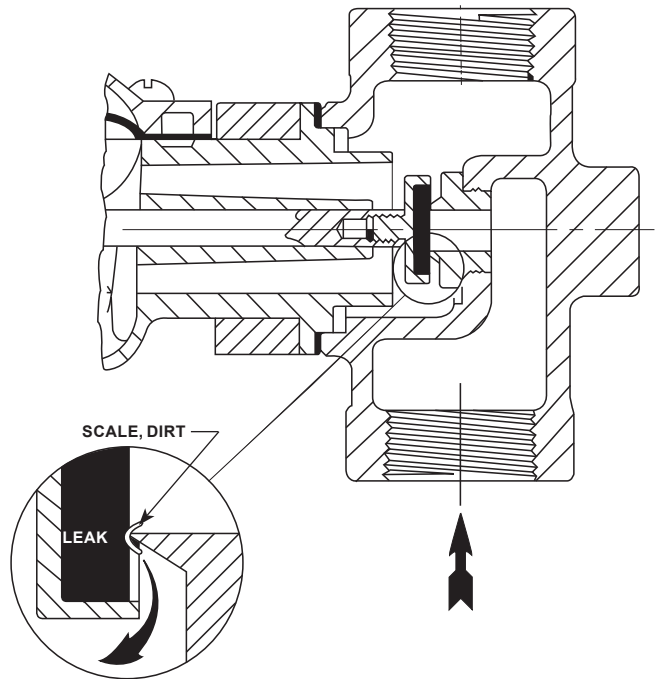


Figure 8. Gas Leakage Caused by Chips Preventing the Disc from Seating Tightly Enough Against the Orifice

While chips are a rough adversary, it still takes a fairly stubborn piece of foreign material to pose serious problems. Many times the powerful force of the valve disc pushing against the orifice can break up the chips and return things to normal.

But no matter what, chips can't be kept away all of the time. The important thing is to recognize the problem. In most instances, simply blowing out the lines and the regulator inlet will clear up the situation.

Worn or Damaged Regulator Disc and Orifice

The orifice "nose" must be carefully formed and handled by the manufacturer. Even a tiny nick that can hardly be seen will cause leakage when the regulator should lock up tight. When a regulator is taken apart, the orifice should be protected as much as possible.

The orifice nose tends to indent the disc even during ordinary operation. After many years, the disc can become indented enough to prevent tight lockup. Nicked orifices and indented discs result in the same problems as foreign material between the disc and orifice; potential internal relief valve discharge out the regulator vent. The solution is also the same—replace the disc and/or orifice.

Water in the Gas

Under certain conditions ice can form at the orifice inlet and prevent gas from entering the regulator (Figure 7). LP-Gas expands as it is reduced to a lower pressure, and it needs heat to expand. The heat comes through the walls of the regulator, making the inlet much colder. If water is present in the gas, it drops out of the gas at the inlet and eventually turns to ice if the temperature stays low enough.

If you suspect water in the LP-Gas, use methyl alcohol (one pint to 100 gal. of fuel). Make sure all tanks and cylinders are thoroughly dehydrated before they go into service. Two-stage systems – a first-stage and a second-stage regulator – are much less susceptible to freeze-ups than a single-stage regulator. This is because more heat can be transferred from the outside through two regulators than just one. The second-stage regulator orifice is larger than a single-stage orifice and therefore more resistant to plugging by ice in the regulator inlet. Finally, since the second-stage regulator does not have a large inlet to outlet pressure differential, the cooling effect on the regulator is less which also minimizes ice formation in the regulator inlet.

Regulator Repair

Regulator repair can fall into the realm of diminishing returns. The cost to replace a regulator may be less than the cost for parts, labor and equipment investment required to repair regulators. Thus it becomes a company decision on repair versus replacing the regulator.

If the regulator is 15 years old or older, just replace the regulator.

Repair

If repair is the policy, always follow the manufacturer's instructions for parts replacement and regulator repair. It's fairly easy to repair regulators. A competent person, some common tools (such as a screwdriver and a crescent wrench), the necessary repair parts and a test rack are required to do the job.

Repair would consist of the following:

1. The valve disc and the diaphragm should always be replaced, especially on units that have been in service for several years.
2. Check the orifice carefully and replace the orifice if it is dented or scratched on the seating surface.
3. Replace any corroded or damaged parts.
4. On reassembly, do not stretch the diaphragm of the regulator like a drum head.
5. Leave the flange screws loose until the adjusting screw has compressed the main regulator spring about half way.
6. Tighten the flange screws and the required diaphragm slack will be assured.
7. Test the regulator for setpoint, lockup and leakage before reusing the regulator.

A test rack is needed for testing the regulator; it is available from most regulator manufacturers although some companies make their own. Every repaired regulator must be closely checked, tested and set before it goes back into service.

No Repair

If repair is not your company policy, there is one check that can be made to potentially save a regulator, especially a relatively new regulator that does not lockup or leaks through the vent. There is a good probability that the lock-up issue or vent leakage is caused by debris in the inlet and at the orifice.

1. Remove the regulator from the line,
2. Blow out the inlet with compressed air,
3. Re-install the regulator and
4. Check lockup and/or vent leakage again.
5. Replace the regulator if it still does not pass the tests.

Summing Up

There's nothing that responds to a little care any better than the LP-Gas regulator. But if it is overlooked, all kinds of troubles can result. Remember these points:

1. Install the regulator with the vent pointing down on outdoor service; use a vent line sized for the vent on underground tanks, regulators installed indoors and where distance requirements from openings or sources of ignition dictate.
2. Keep the vent open and check it periodically to see that it's not blocked. If the vent has a screen, make certain that it is in place. Protect the regulator and vent from snow buildup and ice/snow falling off a roof.
3. Keep in mind that dirt and chips can cause vent leakage and poor lock-up performance. Clean lines and clean gas connections help reduce chip problems. Replacing the valve disc and orifice will usually correct any troubles.
4. Check the vent periodically to make sure it is not plugged or can be plugged.
5. A regulator that has been covered by water during a flood or heavy rain must to be replaced.
6. For residential regulators, it is typically best practice to replace completely.

✉ Webadmin.Regulators@emerson.com

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🌐 LinkedIn.com/company/emerson-automation-solutions

🐦 Twitter.com/emr_automation

Emerson Automation Solutions

Americas

McKinney, Texas 75070 USA
T +1 800 558 5853
+1 972 548 3574

Europe

Bologna 40013, Italy
T +39 051 419 0611

Asia Pacific

Singapore 128461, Singapore
T +65 6777 8211

Middle East and Africa

Dubai, United Arab Emirates
T +971 4 811 8100

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